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ON THE DETERMINANTS OF OPIUM CONSUMPTION; AN EMPIRICAL ANALYSIS OF HISTORICAL DATA

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ABSTRACT

Consumption of drugs is a major problem in modern society. Yet, not much is known about it from an economic point of view. The illegal nature of drug use makes it difficult to collect reliable data for empirical analysis. The current paper avoids this problem by using historical data that are collected under a government regime of legal drug use. In the early twentieth century in the Dutch East Indies (present day Indonesia) there was a government monopoly on opium. We use data from 1930 administrative files on this monopoly to study regional differences in opium consumption. From the nature of these differences we make inferences about the determinants of opium consumption. We find that regional differences in opium policy, in population density and in composition of the Chinese part of the population are the major determinants of regional differences in opium consumption.

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I. INTRODUCTION

Drugs, especially hard drugs cause many problems in modern society like crime, corruption of law enforcement officials and politicians, health risks, et cetera[1]. Yet, not much is known about the conditions that lead some people to use drugs and other people to avoid it. The lack of knowledge is caused by the illegal nature of the drug business, which makes it hard to collect data for empirical analysis. Data that are collected may be highly unreliable[2].

This paper avoids these problems since it uses historical data that are collected under a government regime of legal drug use. In the early twentieth century in the Dutch East Indies (present day Indonesia) there was a government monopoly on opium. A government bureau within the Finance Department controlled this so-called *opium regie*. A lot of Chinese and indigenous adults that wanted to smoke opium could get a permit to do so. Each district had a central opium depot, an extensive network of official opium stores and a network of licensed opium dens where users were allowed to smoke their opium. Vernaculars were posted above the *regie* stores: "Government opium for sale here" (Rush 1990).

The colonial government of the Dutch East Indies produced annual reports on opium consumption that contain information on a district basis about quantities of opium consumed, numbers of opium consumers, et cetera. In Van Ours (1995) information from the period 1923-1938 is analysed. In this study time series characteristics of the opium information are exploited while differences between districts are assumed to be fixed and are left unexplained. Price and income elasticities of the demand for opium are estimated for both Chinese and indigenous consumers. The estimation results are very similar: short-term price elasticities of about -0.7, long-term price elasticities of about -1.0. The estimated short-term income elasticity of opium is about 0.8, the long term about 1.3.

In the current paper we focus on regional differences in opium consumption at one point in time, the year 1930. This year is very suitable for a cross-section empirical analysis since there was a Census that revealed many characteristics of the Chinese and indigenous population which are not available for other years. Furthermore, for the year 1930 the opium information is very detailed. There is information for 56 districts, whereas usually in Dutch colonial publications on opium, 22

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[1] Miron and Zwiebel (1995) analyse these problems from an economic point of view and discuss the pros and cons of drug prohibition. The bottom line of their paper is that a free market in drugs is superior to a policy of prohibition.

[2] A recent and rare example of an empirical study is Grossman, Chaloupka and Brown (1996) in which the frequency of use of cocaine by young adults is investigated. The consumption of cocaine is found to be quite sensitive to its price. Furthermore, the participation in cocaine consumption is lower for blacks, married people and people with frequent religious participation. The frequency of cocaine demand (given positive participation) is lower for people with low earnings and married or engaged people. Finally, there are differences in cocaine consumption between states because of differences in policies with respect to marijuana and alcohol.

districts are distinguished. We use two indicators of opium consumption[3]. The first is "opium penetration" which we calculated as the percentage of the male population that smoked opium. The second is "average opium consumption" which we calculated as the average quantity consumed per male inhabitant.

We want to investigate why some individuals are more vulnerable to opium use than other individuals. We do this by analysing to what extent differences between districts in terms of demographic, socio-economic and opium policy characteristics coincide with differences in opium consumption. An obvious question is whether it makes sense to use district data for this purpose. As a first check we calculated the correlation between both the opium penetration and the average consumption of the Chinese and the indigenous. We did the calculations separately for the 38 districts of Java, the main island of the Dutch East Indies and for the 18 districts of the so-called Outer Isles. We find the correlation coefficient of opium penetration to be significantly positive with a value of 0.66 for Java and 0.59 for the Outer Isles (see Table 3). We conclude that there are district specific effects that cause a positive correlation between the opium penetration of both ethnic groups. The correlation coefficient of the average opium consumption is 0.53 for Java and 0.50 for the Outer Isles. Again, since both correlation coefficients are significantly positive, there must be common district specific determinants. So, it does in fact seem to make sense to use the district data for an empirical analysis of the determinants of opium consumption.

The paper is organised as follows. Section II gives a short description of the opium history. In section III we present demographic and socio-economic information about the Dutch East Indies. In section IV we give an overview of the use of opium and discuss the available information. Section V presents the results of our empirical analysis. Section VI presents the main conclusions from our analysis and indicates which present-day drug policy lessons can be learned from our analysis of the opium history.

II. A SHORT HISTORY ON OPIUM

In the past centuries opium was important business in Southeast Asia. British and American traders brought opium from British India and the Ottoman Empire and exported it in large quantities to China (Maule 1992). In smaller quantities opium was exported to areas with Chinese communities in the Straits Settlements, French Indo-China, Siam and the Dutch East Indies. The use of opium

[3] Information about opium consumption is published in the annual account of the Opium regie of the year 1930 (*Verslag betreffende den dienst der opium regie over het jaar 1930*). Other information about opium consumption is published in the chapter "Finances of the State" in the Colonial reports (*Koloniale verslagen*). Information with respect to the population is published in reports of the Census of 1930 in the Netherlands Indies, Landsdrukkerij, 1936 Batavia, Ministry of Economic Affairs. Furthermore, we use information with respect to income taxes, which we derived from the Colonial report of 1930.

has a long tradition in the Dutch East Indies[4]. In the early 17th century the Dutch took over Malaya from the Portuguese and for a hundred years they auctioned the opium in Batavia to the highest bidder. Since then there have been several ways in which the Dutch government directly or indirectly controlled the opium market in the Dutch East Indies.

In the second half of the eighteenth century the opium supply was controlled by a private organisation, the so-called *Amphioen Societeit*. In exchange for a fixed financial contribution this organisation gained the right to sell opium to the highest bidder. In the nineteenth century there were opium tax farms. Lacking sufficient administrative capacity for collecting taxes the Dutch government sold regional rights to retail opium to the highest bidder.

At the end of the 19th century there was a lot of political discussion in the Netherlands about the pros and cons of allowing Chinese and indigenous inhabitants of the Dutch East Indies to consume opium. Many politicians were in favour of total prohibition. However, the large-scale opium consumption had been a reality for a long time. Total prohibition would be difficult to enforce. By the end of the nineteenth century a new scheme, called *opium regie*, was gradually introduced. Under this scheme import, refinement and retailing were fully under control of the government. The idea of the *opium regie* was not unique. The French introduced an opium monopoly in Indo-China at the end of the 19th century. The same happened in Taiwan, which was a Japanese colony in the period 1895-1945. The Japanese established an Opium Monopoly Bureau that had the exclusive right to produce and sell opium in Taiwan. Wholesale and retail opium merchants as well as opium smoking shops had to apply for a license from the government. Chartered opium pharmacies were established to engage in the sale of opium. Those who were diagnosed by medical doctors as addicts were given a license by the government so that they could purchase opium from chartered pharmacies (Liu, Jin-Tan et al. 1996). The *opium regie* lasted until the Japanese conquered the Dutch East Indies in 1942.

III. DEMOGRAPHICS AND SOCIO-ECONOMIC CHARACTERISTICS

A. Demographics

Table 1 gives information, which we derived from the 1930 Census of the population of the Dutch East Indies. For reasons of presentation we group the 56 districts into three areas: Java with 38 districts, Sumatra with 10 districts and Other Isles with 8 districts[5]. In the Dutch colonial statistics

[4] See for an overview of the history of Indonesia Ricklefs (1993). Maddison (1989) provides information about the economic history of Indonesia. A detailed description of the 19th century history of opium smoking on Java is given in Rush (1990).

[5] The district are the following, where the districts in **bold** had a strict opium regime and those in *italics*

the areas Sumatra and Other Isles are usually grouped into one area: the Outer Isles. Often in Dutch colonial statistics, there is a distinction between three population groups: Dutch, other Europeans and Japanese, Chinese and other Asians, indigenous population. The Dutch part of the population is not mentioned in table 1, because the number of opium users among the 260,000 Dutch inhabitants was very small. The table shows that the Chinese part of the population was also quite small. While there were almost 60 million indigenous there were a little over 1 million Chinese. Java was by far the most crowded area since more than two-thirds of the indigenous population lived there. The Chinese were more evenly spread over the three areas. The share of the adult male population was higher among Chinese than it was among indigenous. This has to do with the many adult male Chinese who immigrated to work as coolies in plantations, especially located in Sumatra. Overall there were about 16 million indigenous adult males and about half a million Chinese adult males.

For male adult indigenous there are substantial differences with respect to literacy. In Java and the Other Isles only about 12% of the male adults were literate, while this was 22% in Sumatra. There was not a lot of difference with respect to the shares of married among male adult indigenous. The literacy among Chinese adult males was much higher with percentages of 65 in Java and of 41 in Sumatra. The percentage of married adult male Chinese was lower than that of indigenous males with an average of 50% and a low number of 41% in Sumatra. For Chinese there were major differences in the percentages of adult males born outside the Dutch East Indies. In Java this was 37%, while in Sumatra it was 82%. The latter is direct evidence of the presence of many Chinese immigrants in Sumatra who were hired from outside the Dutch East Indies to perform specific types of labour.

B. Socio-economic characteristics

Table 2 shows that in 1930 there were several socio-economic differences between the areas. An important distinction between the Chinese in Java, Sumatra and the Other Isles is the occupational

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had a free opium regime.

I. Java: **Banten**, *Batavia*, **Buitenzorg**, **Krawang**, **Ceribon**, **Indramayu**, **West-Priangan**, **Mid-Priangan**, **East-Priangan**, Pekalongan, Tegal, *Semarang*, Kudus, Rembang, Blora, **North-Banyumas**, **South-Banyumas**, **Wanasaba**, Kedu, **Bagelen**, *Surabaya*, Mayakerta, Grisee, Bodjanegara, Madiun, Panagara, Kediri, Blitar, Pasuruan, Malang, Prababingga, Bandawasa, Djember, West-Madura, East-Madura, Yogyakarta, Klaten, Surakarta.

II. Sumatra: **Sumatra's West Coast**, **Tapanuli**, Bengkulu, Lampung Districts, *Palembang*, **Jambi**, *Aceh, Sumatra East Coast, Riau and Dependencies*, Bangka, *Belitung*.

III. Other Isles: West-Borneo, South- and East-Borneo, *Celebes*, Manado, **Moluccas**, *Timor and Dependencies*, **Bali and Lombok**.

structure. From the 1930 Census it appears that almost 60% of the Chinese in Java were involved in trade and commerce whereas only 10% participated in the production of raw materials (mostly agriculture). In Sumatra 50% of the Chinese were engaged in agriculture and the production of raw materials. For the other Outer Isles this was 23%. In Sumatra the percentage of Chinese involved in trade was relatively low, while in the Other Isles this was a considerable percentage. The indigenous population was mainly involved in agriculture, with only a few percent working in manufacturing or trade.

The differences in structure of the working population are also reflected in the income of the people. The average per capita income of the Chinese was about five times as high as the per capita income of the indigenous population. In many respects the Chinese formed a middle class between the Dutch and the indigenous inhabitants of the Indian Archipelago. While the Dutch were mainly involved in the civil service, the army, foreign trade and agricultural production for exports, and the indigenous population was mainly involved in agriculture and fishing, the main Chinese occupation was commerce, which covered over one-third of working Chinese in the Census of 1930. Nearly one-fifth was engaged in industry, mainly as small craftsmen, and the rest was distributed between gardening, agriculture, and coolie labour on Dutch-owned plantations and mines.

The differences in income also show if we compare the shares of males that had to pay income tax. Only those with an annual income of more than 120 Dutch guilders had to pay income tax. Of the indigenous male population 6% had to pay income tax, for the Chinese population this was 35%. There are also marked differences between areas. Whereas 3% of the indigenous males in Java had to pay income tax, this was 19% in Sumatra. The bulk of the indigenous income tax payers in Java were salary earners. Most of the taxpayers outside Java were in the lowest income bracket. Outside Java the great majority of the indigenous income taxpayers were own-account workers (Booth 1988). All in all, Table 2 shows a sharp contrast between the indigenous and the Chinese part of the population (see also The Siauw Giap 1989). The Chinese were a minority in numbers, but on average their social and economic position was much better than that of the indigenous population (which is still the case in present-day Indonesia).

The districts can be characterised using various indicators. Table 3 presents three of them: the percentage of Chinese born outside the Dutch East Indies, the population density of males (males/km^2) and the average amount of income tax paid (guilders per male inhabitant). Table 3 shows that the correlation between the percentages of foreign-born Chinese and the population densities is low. Apparently, in districts where the population density is high there is no disproportional share of foreign born people in the Chinese community. In the Outer Isles there is no significant correlation between the amount of income tax paid and the population density or the percentage of foreign-born Chinese. However, in Java there is a significant positive correlation between the amount of income tax paid and both the population density and the share of Chinese born. Apparently, Javanese districts with a lot of wealth were also

districts that had experienced a big inflow of foreign born Chinese. Economic wealth is correlated with influx of Chinese workers from outside the Dutch East Indies.

IV. OPIUM USE

A. Main characteristics

In 1930 the so-called *Tjandu* was the only type of opium that was sold officially in the entire Dutch East Indies. The *Tjandu* of the state had a standard quality. It contained 11-13 percent morphine. Considering the narcotic effects, today one would call pure *Tjandu* a hard drug. Opium smokers were predominantly male. We ignore the occasional female opium smoker and use the percentage of males smoking opium as an indicator of opium penetration. From table 4 it appears that on average a relative large share of the Chinese males used opium. In Sumatra on average about 20% of the Chinese males used opium. In Java and the Other Isles opium penetration was about 5%. The opium penetration among indigenous males was on average about 0.3%, being the highest in Java. Chinese opium smokers on average about 460 grams per year, the indigenous smokers used on average 140 grams per year. There were substantial differences between the areas. For Chinese opium smokers the average consumption varied from 400 grams per year in Sumatra to 850 grams per year in the Other Isles. For Indigenous opium smokers consumption ranged from 130 grams in Java to 230 grams in the area of the Other Isles. As an indicator of average opium consumption we use the average amount of opium per male inhabitant, which is the product of opium penetration and the average amount per smoker. For the Chinese males the average consumption was about 50 grams of opium per year, the Indigenous males on average consumed 0.3 grams of opium per year.

The average annual amount of money spend on opium was about 100 guilders for an indigenous smoker and about 320 guilders for a Chinese smoker. Again, there are big differences between areas. The average amount spend by indigenous smokers in the Other Isles was 175 guilders, while in Java this was 101 guilders. Chinese opium smokers spent on average 621 guilders in the Other Isles and 252 guilders in Sumatra. Opium smokers must have spent a large amount of their income on opium since the average income per head of the working population was 170 guilders for indigenous and 840 guilders for Chinese (Polak 1943).

Opium was big business in the Dutch East Indies. The production of refined opium made from imported raw opium was done in an opium factory in Java with about 600 employees. Opium was distributed from this factory to depots and then to shops. In total there were 7 depots in Java and 10 in the Outer Isles. The number of shops where consumers could buy opium was 583 in Java and 468 in the Outer Isles.

B. Opium policy

The government basically had prices and permits as its two policy instruments to influence opium consumption. While in Java opium had the same price in every district, in 5 of the districts in Sumatra and 1 district in the Other Isles there was a substantial lower price. The average price over the whole of Sumatra was 632 guilders per kilogram of opium, while the most common price per kilogram was 777 guilders.

In different areas there were different opium policy regimes. The most strict were so called closed areas, where opium use was prohibited, although in cities within these areas opium use was allowed for licence holders (in fact in none of the 56 districts opium consumption was equal to zero). Under a less strict policy opium smoking was allowed for people with a licence. Under the least strict policy opium smoking was free apart from general restrictions. As indicated in Table 4 there were 17 districts with a strict regime and 10 district with a free regime. The main reason for differentiating policy along regional lines was that the opium smoking habit did not occur everywhere at the same level. The imposition of a strict policy regime was related to the opium smoking habits of the indigenous population. In some areas, like the Islamic districts of West Java, opium smoking among indigenous was not widespread. If opium smoking among the indigenous was almost absent, the sale of legal opium - if there was any - was stopped, and the use of opium was actually forbidden. In other districts opium smoking was almost as common as nowadays alcohol drinking in Western countries. This was especially the case in districts with substantial Chinese communities or districts with large estates like the East Coast of Sumatra. The labour force on these agricultural, export-producing estates was to a large degree recruited from other parts of East Asia, and many of these displaced temporary contract workers proved to be opium smokers on arrival, or else soon afterwards. By and large the Chinese population and contract workers (often overlapping categories) were subject to less strict opium rules than the indigenous population of the Dutch East Indies.

As a first investigation of the effect of the opium regime on opium use, we cluster the districts into three groups: districts with a strict regime, districts with a free regime and districts with an intermediate regime. The average characteristics of the three clusters are presented in Table 5. On the basis of this table we characterise the differences between the opium regimes as follows. Districts with a strict opium regime, of which 12 of the 17 are in Java, differ from the other districts in terms of population density and wealth as measured by taxes paid. Strict regime districts have a higher population density, which is probably caused by the high share of dense populated Javanese districts. Under a strict regime the opium penetration and average opium consumption of both Chinese and indigenous is lower than in the other districts. Districts with a free regime have a high share of Chinese born outside the Dutch East Indies. Opium penetration for Chinese in free regime districts is high, but for

indigenous in this type of districts it is not different from the districts with an intermediate regime. Our conclusion from this is that the strict opium regime is applied in those districts where the inclination among indigenous towards smoking opium was small anyway. The fact that also among Chinese opium penetration is smaller than in other districts seems to indicate that the strict opium had a discouraging influence on opium use. Districts with a free opium regime were present in the big (harbour) cities of Java (Batavia, Semarang, and Surabaya) and in other districts with many Chinese not born in the Dutch East Indies. After correcting for the nature of the opium regime at the district level there is a relationship between the opium penetration among Chinese and among indigenous, so the positive correlation between the two is not created by the nature of the opium regime.

To fight opium smuggling there was an opium police force that also had steamships to fight opium smuggling over sea. As indicated in Table 4 the amounts of illegal opium intercepted by the opium policy were limited. All in all, there was some ambiguity in the government policy towards opium. On the one hand the government was earning a lot of money from selling opium. Total government revenue in 1930 was about 35 million Dutch guilders. On the other hand the government supported societies who had campaigns against the use of opium. However, since the government paid only 11,000 Dutch guilders in 1930 this support was limited in financial terms.

C. Hospitalised opium smokers

Official information with respect to opium use does not indicate that opium addiction was a severe problem. In several hospitals opium addicts were treated for medical reasons, but their numbers are small as compared to the total number of opium users. In 1930 in the Bandung hospital 2 Europeans, 23 indigenous and 224 Chinese were treated of which 195 were declared cured after their treatment. In Modjowarna in 1929 14 indigenous and 10 Chinese were treated for their addiction. In Surakarta 115 male and 2 female Chinese, 68 male and 8 female indigenous were treated, of which 174 were declared cured after their treatment, whereas 19 failed to be cured. Medical doctor Anthony de Mol van Otterloo (1933) did some research among 200 opium smokers in the opium hospital Immanuel in Bandung. He concludes that the average opium smoker was 35 years old, had been using opium for 10 years and used 1400 grams of opium on an annual basis. In his judgement a smoker who used less opium than this amount was a light smoker and easy to cure. Someone who used more than 1400 grams of opium was considered a heavy smoker and difficult to cure from his opium addiction. Note that this amount is substantially higher than the average amount opium smokers consumed (see Table 4). Therefore, the number of heavy smokers was substantially smaller than the number of light opium smokers. Of course one has to take into account that only heavy opium smokers ended up in the hospital. De Mol van Otterloo (1933) published individual information about some 25 opium

smokers. From this information we find that the use of opium ranged from 850 grams per year to 6300 grams per year. The average amount over the 25 smokers was 2390 grams/year, while the average drops to about 2000 grams after omitting the three most heavy smokers. Almost every opium smoker was Chinese and male (there was 1 female). Of 18 individuals we know the age and the duration of their opium smoking. It appears that the coefficient of correlation between the amount consumed and the age of the consumer is insignificant (-0.28). Amount and duration are hardly correlated (correlation coefficient =-0.03), but there is a significant coefficient of correlation of -0.47 between the amount consumed and the age at the start of the opium smoking. So, the higher the age at which consumers started smoking, the smaller the quantities they smoked later on.

V. EMPIRICAL ANALYSIS

A. Univariate analysis

To get an impression about the possible determinants of district differences in opium penetration among Chinese we calculated the coefficients of correlation between on the one hand our indicators of opium consumption and on the other hand some district characteristics. These district indicators are the percentage of Chinese born elsewhere, the population density and the per capita income tax paid in 1930. The null hypothesis is that there is no correlation between the opium indicators and the characteristics of the districts. We test whether we can accept this null hypothesis or whether we have to reject it and accept that there is correlation between the variables involved.

The results are presented in the correlation matrix in Table 3. There is a significant positive correlation between the population density and opium penetration of Chinese in Java. This is easily explained by the fact that in Java many Chinese live in big cities that have a less strict opium policy. Population density does not coincide with any of the other opium characteristics. Wealth in a district as measured by the per capita income tax is positively correlated with opium penetration and average opium consumption, again only in Java. These correlations probably have the same origin as the previous one since, as indicated before, there is a positive correlation between population density and income tax in the Javanese districts. The percentage of foreign-born Chinese is significantly positive correlated with the opium penetration of Chinese in the Outer Isles and with the average opium consumption of Chinese in both Java and the Outer Isles. All in all, there are not a lot of significant correlations between the indicators of opium use and the characteristics of the districts.

B. Multivariate analysis

Apart from univariate analyses we also perform multivariate analyses using the following equations:

$$G_{ij} = \beta_{oj} + \beta_{1j} X_i + \epsilon_{ij} \quad (1)$$

$$Q_{ij} = \gamma_{oj} + \gamma_{1j} X_i + \upsilon_{ij} \quad (2)$$

where G is the opium penetration, i = 1,.., 56 is an indicator of the district, j =1,2 is an indicator of the population group (indigenous, Chinese), while X is a vector of characteristics of the districts. Furthermore, Q is the average opium consumption, the β's and γ's are regression coefficients and ϵ and υ are error terms.

We use the following explanatory variables, all specified at the district level:

- Opium regime: As indicated before there where different types of opium policy. As in Table 5 we distinguish three types of districts. We use a dummy variable that has a value of 1 for the strict regime districts and a value of 0 otherwise. We also use a dummy variable that has a value of 1 for the free regime districts and a value of 0 otherwise. Thus, the reference group consists of the districts with an intermediate policy. We expect that forbidden districts will discourage opium smoking of Chinese. For the indigenous there is a problem of endogeneity in the sense that forbidden districts have originated from the fact that in these districts opium use among indigenous already was low. For the Chinese population the type of opium policy may be considered exogenous. Since for the indigenous population the strictest regime may be endogenous for the indigenous we omitted districts with forbidden areas.
- Low price: We use a dummy variable with value 1 if the district had a lower opium price than the 777 guilders per kilogram that was paid in most districts and with a value of 0 otherwise. We use a dummy variable in stead of a continuous variable since the price is either high or low. Districts with lower prices are expected to have a larger opium penetration and therefore also a higher average per capita opium consumption.
- Population density (male inhabitants/km^2): This variable is expected to have a positive effect on opium penetration. The higher the density of the population the more easy it is to consume opium because of the neighbourhood of opium shops, dens, et cetera.
- Percentage of male Chinese born outside the Dutch East Indies: As indicated before there are large differences in this share that probably reflects the extent to which the Chinese males are working as a 'coolie'. The hard labour of these Chinese also stimulated their opium consumption. So, we expect this variable to have a positive effect on the penetration of opium use among Chinese.
- Income tax per male inhabitant: This variable reflects the average wealth within a district and is expected to have a positive effect on opium penetration.

Equations (1) and (2) are estimated using ordinary least squares. To account for possible heteroskedasticity the standard errors were calculated using the White estimator for the variance matrix of the least squares estimator.

The estimation results are shown in Table 6. Most of the results for the Chinese population are as expected. It appears that opium penetration among Chinese males is lower in districts with a strict regime and higher in districts with a free regime. Furthermore, opium penetration is higher in districts with low opium prices, with a high population density and a large share of foreign-born Chinese. Districts with more income tax have a smaller opium penetration, but the coefficient is not different from zero at conventional levels of significance. The results with respect to the average opium consumption of Chinese males are quite the same. Only now, the coefficient of the income tax variable is significantly smaller than zero. We discuss possible explanations for this phenomenon in the next subsection.

The regressions for the indigenous part of the population are performed for a smaller number of districts. In the 'forbidden areas' there was hardly any or even no indigenous opium smoker. We skipped district with fewer than 20 opium smokers. This reduces the number of districts in the analysis from 56 to 45. The results of the regressions for the indigenous part of the population are also shown in Table 6. The effects of a strict regime, a low price and a high population density are very similar to what we find for the Chinese. A striking difference is that in free regime districts neither the opium penetration nor the average consumption of indigenous males is different from the reference group. Also, the percentage of foreign-born Chinese does not influence opium penetration or opium consumption among indigenous people. Apparently, this indicator reflects above all differences in opium use between incumbent Chinese and foreign-born Chinese, while it does not reflect differences in characteristics between districts. The income tax variable does not affect opium penetration or consumption among indigenous males.

C. Light smokers and heavy smokers

There are big differences between districts in terms of the characteristics of opium use. In Riau (8,000 smokers) and the East Coast of Sumatra (37,000 smokers) about 28% of the Chinese males was opium smoker with an average annual consumption per smoker of about 500 grams. On the other hand there were Celebes (413 smokers) and the Moluccas (275 smokers) with a penetration of 2-3% but a consumption per smoker of 1250 grams per year. Although for the indigenous population both penetration and average consumption are much smaller than they are for the Chinese population here too there is a wide variety with Surakarta (17,000 smokers) as the district with the highest opium penetration but a low consumption per smoker and Jambi (5 smokers), Bangka/Billiton (8 smokers) and West-Borneo (9 smokers) with a high consumption per smoker but a very low penetration. At the district level there appears to be an inverse relationship between

the opium penetration and the average amount of opium an opium smoker consumed. This relationship may be caused by differences between the districts with respect to the distribution of opium smokers in terms of the quantities they consume. If the differences in total opium penetration are to a large extent differences in the opium penetration of small consumers, then such an inverse relationship originates.

We pursue this possibility by tentatively distinguishing two types of opium smokers. We assume that in every district there is a discrete distribution of opium users with 2 points of support, implying that there are 2 types of smokers, light smokers and heavy smokers. Then the following holds:

$$G_{ij} = \Sigma_k G_{ijk} \quad (3)$$

$$Q_{ij} = \Sigma_k (G_{ijk} . Y_{ijk}/100) \quad (4)$$

where k=1,2 is an indicator of the type of opium smoker (light, heavy) and Y is the average consumption per opium smoker. Now, since equations (3) and (4) have 4 unknowns for every district and population group (G_{ij1}, G_{ij2}, Y_{ij1}, Y_{ij2}), we cannot do any further analysis without making additional assumptions. Therefore, we assume $Y_{ij1}=Y_{j1}$ and $Y_{ij2}=Y_{j2}$ implying that a light smoker has the same annual consumption in every district and the same holds for every heavy smoker. So in every district the two types of smokers are the same. The district variation in average opium consumption originates from district differences in the distribution of light and heavy smokers. For the Chinese the largest annual district opium consumption per smoker is 1250 grams and the smallest is 500 grams. So, we know that $0<Y_{21}\leq 500$ and $Y_{22}\geq 1250$. However, since the g_{i2k}'s are allowed to vary within these boundaries, theoretically there is an infinite number of combinations (Y_{21}, Y_{22}) that will generate the data on average opium consumption. Therefore, we impose that that in every district Chinese heavy smokers use 2000 grams of opium per year, while all the light smokers use 200 grams per year[6]. Then, given that the average opium penetration is 10.4% and the average consumption per opium smoker is 460 grams per year, on average there are 1.6% Chinese heavy opium smokers and 9.2 % Chinese light opium smokers[7].

For the indigenous males we follow the same procedure. The average indigenous opium penetration is 0.3% and the average consumption per indigenous opium smoker is 140 grams per year. If we assume that heavy indigenous smokers use 1000 grams of opium per year and light

[6] Note that the 2000 grams per year for a heavy smoker is in line with the information of De Mol van Otterloo (1933) about heavy opium smokers.

[7] These results are not particularly sensitive to assumptions about the quantities for light and heavy smoker. If we assume that a light smoker has 100 grams per year and a heavy smoker 4000 grams, the penetration of heavy smokers is 1% and the penetration of light smokers is 9.8%. If we assume that a heavy smoker has 1500 grams and a light smoker has 200 grams, the penetration of a heavy smoker is 2.2% and the penetration of a light smoker is 8.6%.

indigenous smokers use 100 grams per year, the average penetration of heavy smokers is 0.01% and the average penetration of light opium smokers is 0.29%.

We can study the effect of district characteristics on the penetration of heavy and light opium consumers by specifying the following relationships:

$$G_{ij1} = \beta_{oj1} + \beta_{1j1} X_i + \epsilon_{ij1} \quad (5)$$

$$G_{ij2} = \beta_{oj2} + \beta_{1j2} X_i + \epsilon_{ij2} \quad (6)$$

After plugging equation (5) and (6) into (3) and (4) we have two equations of which the coefficients can be estimated. So, even although we do not observe the penetration of light and heavy smokers, under the assumptions we made we can investigate the way district characteristics affect them. Note that in doing this we basically give a different interpretation to the estimates of equations (1) and (2)[8].

In the same way as before in the estimations we account for the possible presence of heteroskedasticity. The estimation results are shown in the lower part of Table 6. It appears that the presence of a strict opium regime has a negative effect on the penetration of heavy and light smokers of both population groups. Free districts have a larger penetration of both types of Chinese consumers but a smaller penetration of both types of indigenous consumers. Low prices do not affect the penetration of Chinese heavy opium smokers. Apparently, their income is so high, that prices are not important. Chinese light and both types of indigenous opium smokers do have a higher penetration in low price districts. Population density has a positive effect on the penetration of all types of consumers. The percentage of foreign-born Chinese only has an effect on the opium penetration of both types of Chinese consumers. Finally, the per capita income tax only affects the penetration of the heavy Chinese and indigenous consumers. It could be that smoking opium was more a habit among middle class Chinese and indigenous then it was among higher class - higher income earners.

For both Chinese and indigenous the coefficients of the penetration equations for light smokers are substantially larger than the coefficients of the penetration equations for heavy smokers. Apparently the penetration of light smokers was more sensitive to government policy or differences in the characteristics of the population. It also means that the differences in opium penetration between districts are mainly related with differences in penetration of light opium smokers. This, of course, explains the inverse relationship between penetration and consumption per smoker.

VI. CONCLUSIONS

It is not easy to do economic research in the area of drug consumption because of the illegal nature

of drug use. This paper avoids problems related to the illegal nature by using data from a period in time when the drug investigated, opium, was not illegal at all. In fact, in the period of time, 1930, and the area under consideration, the Dutch East Indies, opium business was controlled by the government. The use of opium was widespread among the Chinese but also among a substantial number of indigenous inhabitants. To investigate the determinants of opium use we analysed a small dataset with information about hospitalised opium smokers and we analysed an administrative dataset containing information about opium smoking in 56 districts within the Dutch East Indies. In 1930 there was a big difference in the socio-economic position of Chinese and indigenous inhabitants. The Chinese had a higher income than the indigenous. The indigenous population was mainly involved in agriculture and fishing, whereas the Chinese were more in commerce, industry and coolie-labour. Despite the huge differences between the two population groups the results of the analysis for the two groups are very much the same.

The government in the Dutch East Indies imposed different opium policy regimes to different districts. In districts where the opium smoking among the indigenous was small anyway a strict policy regime was introduced. However, for Chinese inhabitants of these districts it was still possible to consume opium. Although for the indigenous the causality runs from low consumption to policy regime for Chinese the imposition of a strict regime was exogenous to their consumption.

For both population groups we have district level information with respect to both opium penetration (the share of males smoking opium) and average opium consumption (the quantity of opium per male inhabitant). Under specific assumptions with respect to the distribution of light and heavy consumers and the amounts they consume we are able to study the determinants of the penetration of both types of smokers.

Of course the results of our analysis apply to the population of a specific geographical area in a particular period of time. Still, from the opium history some lessons can be learned for the drug policy of today. First, we find that in districts with strict opium regimes the opium penetration among Chinese was lower. So, making it more difficult for people to acquire drugs will reduce drug use, even in cases where drugs are no longer illegal. Second, differences between the districts were mainly due to differences in the numbers of light smokers. The amount of heavy smokers was apparently not much affected by government policy or socio-economic conditions. This indicates that it is difficult to influence heavy drug users but much easier to influence recreational drug users. Third, in districts with high opium price opium penetration was smaller. So, even if drugs are no longer illegal a high price policy is recommendable. All in all, we think these are valuable lessons from opium history.

[8] In fact the coefficients in equations (3) and (4) are linear combinations of those in equations (1) and (2).

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Table 1 Demographic characteristics in the Dutch East Indies by area and ethnic group in 1930

	Java	Sumatra	Other Isles	Total
Population (million)				
Indigenous	40.9	7.7	9.6	59.1
Chinese	0.6	0.4	0.3	1.3
Population density (inhabitants/km^2)	313	17	12	40
Adult male population (million)				
Indigenous	11.1	2.3	2.8	16.2
Chinese	0.2	0.2	0.1	0.5
Male Adult Indigenous				
Literate (%)	11	22	13	13
Married (%)	77	73	67	75
Male Adult Chinese				
Literate (%) [a)]	65	41	41	51
Married (%)	55	43	57	50
Born outside Dutch East Indies (%)	37	82	60	61

[a)] No separate information for Sumatra and the other isles is available

Table 2 Income and labour market characteristics in the Dutch East Indies by area and ethnic group in 1930

		Java	Sumatra	Other Isles	Total
Employees by sector (%)					
Indigenous:	Agriculture	74	83	86	77
	Manufacturing	14	4	4	5
	Trade	3	3	7	3
Chinese:	Agriculture	9	50	23	32
	Manufacturing	21	19	22	20
	Trade	57	18	44	12
Income per male head (guilders) [a)]					
Indigenous [b)]		113	132	132	120
Chinese		563	479	479	517
Income tax payers per male head (%) [c)]					
Indigenous		6	38	12	12
Chinese		45	67	62	57

[a)] Chinese include other Asiatics
[b)] No separate information for Sumatra and the other isles is available
[c)] Data from 1928

Table 3 Correlation coefficients district information [a) b)]

	$g_{Chinese}$	$q_{Chinese}$	$g_{Indigenous}$	$q_{Indigenous}$	**pop**	**taxes**	**born-out**
$g_{Chinese}$	x	0.80**	0.66**	-	0.40**	0.28**	0.18
$q_{Chinese}$	0.88**	x	-	0.53**	0.15	0.30**	0.36**
$g_{Indigenous}$	0.59**	-	x	0.97**	0.02	0.27*	0.12
$q_{Indigenous}$	-	0.50**	0.98**	x	-0.03	0.23	0.04
pop	-0.02	0.02	0.25	0.26	x	0.49**	-0.05
taxes	0.14	-0.04	0.14	0.19	-0.26	x	0.33**
born-out	0.63**	0.62**	-0.16	-0.17	-0.35	0.38	x

[a)] g = opium penetration, q = average opium consumption, pop = population density males, taxes = income tax per male head, born-out = share of Chinese population born outside the Dutch East Indies

[b)] North-east of the x-diagonal are the correlations for Java, South-west of the x-diagonal are the correlations for the Outer Isles

* (**) is a correlation coefficient significantly different from zero at a 1%-level (5%-level) of significance

Table 4 Opium users and opium consumption in the Dutch East Indies by area and ethnic group in 1930

	Java	**Sumatra**	**Other Isles**	**Total**
Opium penetration (% of males)				
Indigenous	0.4	0.2	0.1	0.3
Chinese	5.0	18.9	3.6	10.8
Opium consumption (kilograms/user)				
Indigenous	0.13	0.18	0.23	0.14
Chinese	0.58	0.40	0.85	0.46
Opium consumption (guilders/user)				
Indigenous	101	113	175	105
Chinese	450	252	621	316
Opium price (guilders/kilogram)	777	632	738	701
Illegal opium (%)	1.3	0.2	0.8	0.7
Low price districts (number)	0	5	1	6
Strict regime districts (number)	12	3	2	17
Free regime districts (number)	3	5	2	10

Table 5 Characteristics of districts with different opium regimes

	Strict regime	Free district	Other districts	Total	
Population density (100 males/km^2)	0.34	0.14	0.18	0.20	
Income tax per male head (guilders)	0.82	2.44	0.81	1.12	
Chinese born outside (%/adult male)	31	48	51	50	
Low price districts (number)	2	3	1	6	
Chinese opium penetration (%/male)	3.2	16.7	6.1	10.8	
Indigenous opium penetration (%/male)		0.06	0.29	0.46	0.30
Chinese consumption (grams/male)	24.0	70.0	34.4	49.8	
Indigenous consumption (grams/male)	0.10	0.37	0.63	0.40	
Number of districts	17	10	29	56	

Table 6 Estimation results penetration and consumption for the Chinese and Indigenous population[a)]

	Chinese Penetration	Consumption	Indigenous Penetration	Consumption
Strict regime	-1.83 (2.0)**	-11.6 (2.3)**	-0.40 (3.9)**	-0.55 (4.1)**
Free regime	3.04 (1.5)	12.5 (1.7)*	-0.09 (1.0)	-0.17 (1.8)*
Low price	6.19 (2.2)**	15.8 (1.7)*	0.30 (2.9)**	0.49 (3.2)**
Pop.density males	1.79 (2.2)**	9.56 (3.1)**	0.19 (3.5)**	0.22 (3.2)**
Born outside	0.14 (3.6)**	0.96 (4.3)**	-0.001 (0.4)	-0.002 (0.4)
Income tax	-0.43 (0.8)	-6.01 (3.4)**	-0.02 (0.9)	-0.05 (0.6)
R^2	0.540	0.542	0.339	0.341
Penetration[b)]	**Heavy smokers**	**Light smokers**	**Heavy smokers**	**Light smokers**
Strict regime	-0.44 (2.1)**	-1.39 (1.7)*	-0.017 (3.4)**	-0.39 (3.9)**
Free regime	0.35 (1.3)	2.69 (1.4)	-0.009 (1.8)*	-0.08 (0.9)
Low price	0.19 (0.6)	6.00 (2.2)**	0.020 (2.7)**	0.27 (2.8)**
Pop.density males	0.33 (2.8)**	1.46 (1.9)*	0.003 (1.2)	0.19 (3.5)**
Born outside	0.04 (4.1)**	0.10 (3.1)**	-0.0001 (0.2)	-0.001 (0.4)
Income tax	-0.29 (4.0)**	-0.15 (0.3)	-0.003 (2.0)**	-0.017 (0.8)
R^2	0.540	0.542	0.339	0.341

[a)] Absolute t-values in parentheses; the constants of the regression-equations are not shown; R^2: correlation coefficient.

[b)] Assumption: Chinese heavy opium smokers use 2000 grams per year, light smokers 200 grams per year. Indigenous heavy opium smokers use 1000 grams per year, light opium smokers 100 grams per year.

* (**) is a coefficient different from zero at the 10%-(5%-)level of significance.